Intelligent Vehicle Initiative

Business Plan

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Intelligent Transportation Systems
Joint Program Office

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1—Executive Summary

The personal, social, and economic costs of motor vehicle crashes include pain and suffering, direct costs sustained by injured persons and their insurers, and, for many crash victims, a lower standard of living or quality of life. The taxpayer and society are burdened by unnecessary health care and public assistance costs, lost productivity, and associated loss of tax revenues. During the past two decades, motor vehicle collisions accounted for over 90 percent of all transportation fatalities and an even larger percentage of transportation accidents and injuries. Over 40,000 people die each year in motor vehicle crashes, and the total economic loss to U.S. society is estimated at over $150 billion annually. Driver error is cited as the primary cause in about 90 percent of all police-reported crashes involving passenger vehicles, trucks, and buses.

Ongoing and recently completed research and development indicate that collision avoidance systems offer the potential for significantly reducing motor vehicle crashes. Preliminary estimates by the National Highway Traffic Safety Administration (NHTSA) show that rear-end, lane change, and roadway departure crash avoidance systems have the potential, collectively, to reduce motor vehicle crashes by one-sixth, or about 1.2 million crashes annually. Such systems may take the form of warning drivers, recommending control actions, and introducing temporary or partial automated control of vehicles in hazardous situations.

Recognizing that these and other driver assistance systems potentially offer major benefits, the U.S. Department of Transportation (U.S. DOT) is embarking on a new program called the Intelligent Vehicle Initiative (IVI). The U.S. DOT intends to jointly define the program plan and conduct the IVI in cooperation with the motor vehicle, trucking, and bus industries, State and local governments, and other stakeholders to facilitate the research, development, testing, evaluation, and deployment of safety- and mobility-enhancing systems. Sensing, processing, communications, actuation, and control technologies will be integrated, installed, and evaluated in vehicles and on roadways. These integrated technologies will be linked to in-vehicle driver displays that adhere to well-founded human factors requirements.

Goals:

The primary goal of the IVI is—jointly with the motor vehicle and trucking industries, State and local DOTs, and other stakeholders—to accelerate the development, introduction, and commercialization of driver assistance products to reduce motor vehicle crashes and incidents.

The IVI will support the goal of providing a safer transportation system by reducing the number and severity of vehicle collisions. The IVI also will support other key transportation goals, including those to increase mobility, improve energy efficiency and environmental quality, improve the productivity of the national transportation system, and strengthen the competitiveness of the U.S. transportation industry in the international marketplace.

Focus:

The IVI will emphasize the development of industry-wide architectures and standards, integrated system prototyping, and field test evaluations so that the Government and industry participants can assess benefits, define the performance requirements, and accelerate the deployment of incremental driver-assistance products.

Although the vast majority of crashes occur in the passenger car fleet, the IVI program will not focus solely in this area because it may be beneficial to first evaluate some systems in the transit, commercial, and specialty vehicle fleets. Certain application in these fleets may have less financial, institutional, and technical barriers to early implementation. These activities are expected to deliver benefits that can be leveraged by all platform types. For example, the Federal Transit Administration (FTA) estimates that deaths and injuries from bus crashes account for $800 million in annual insurance claims. Over the past 5 years there have been 30,000 annual bus crashes resulting in 17,000 deaths and injuries. Unlike the passenger car industry, technology innovation in transit is driven by the Federal Government through guidance and financial incentives, and the transit properties through their own vehicle specifications. Additional advantages of the transit community are the increased vehicle costs, increased driver training required, and limited operational areas. In this environment it may be easier to evaluate the use of longitudinal and lateral vehicle control for driver assistance on transit buses than on the passenger cars.

Program Objectives:

- **Accelerate the introduction of driving information, driver assistance, and control systems that will improve significantly the safety of motor operations.**
- **Develop and validate performance specifications and design guidelines for IVI systems that will be deployed in motor vehicles in the next 10 years.**
- **Recognize the complexity of the driving task and issues such as risk compensation and workload, demonstrate IVI systems and evaluate their impact on driving safety.**
- **Reach agreement on the basic functional requirements for driver assistance features, and target those functionalities for which industry investment has developed the basis for working prototypes.**
- **Recognize the need for balance between public benefit and private incentive, ensure that reasonably achievable safety benefits are identified.**
- **Identify refined and more detailed estimates of benefits in order to assess which infrastructure deployment investments can be justified and to stimulate new safety products.**
- **Identify and conduct the research and development required to achieve increased levels of IVI system capability.**

2—Introduction

Motor vehicle crashes create a significant burden in our society in terms of fatalities, injuries, and economic costs for resulting emergency and health care, property damage, and highway congestion, with more than 40,000 motor vehicle fatalities and related costs exceeding $150 billion per year. If highway safety is to be improved significantly and this costly toll reduced, the number of highway crashes must be reduced.

Driver error is the predominant cause of highway crashes. One way of reducing driver error is to help drivers avoid crashes. New technologies are becoming available that can help drivers operate their vehicles more safely and efficiently. These technologies can provide collision avoidance capabilities as well as motorist-information and driving assistance.

The U.S. DOT is launching the IVI to increase the understanding of the abilities of these technologies to solve highway safety problems.

Within the ITS Program, the U.S. DOT has established research and development efforts to improve driving safety and efficiency. These include the Driver Vehicle Interface, Collision Avoidance, and Automated Highway System Programs. The IVI will take advantage of these maturing U.S. DOT programs and the synergism inherent in their close coordination. The IVI will unite these programs into a common framework leading to possible multifunctional integration of proven component systems with a strong emphasis on human-centered considerations. Longer term research and development will be linked to near-term deployability.

3—The Vision and Mission

3.1—The Vision

The U.S. DOT vision is a roadway system that will enable Americans to:

1) **operate in a significantly safer environment, and**
2) **enjoy greater mobility and efficiency, as a result of the widespread use of vehicle-based autonomous and infrastructure-cooperative driving assistance features.**

3.2—The Mission

The mission of the U.S. DOT, with regard to the IVI program, is to provide leadership, expertise, resources, and information to continually improve the quality of our Nation's roads and the vehicles which operate on them. The U.S. DOT undertakes this mission jointly and in cooperation with all its partners to reduce motor vehicle crashes and the resulting injuries and fatalities; enhance mobility by improving public access to activities, goods, and services and increase productivity by improving travel efficiency and reducing travel time.

With regard to the IVI, the Department will fulfill its mission by facilitating the development, evaluation, and deployment of vehicle-related safety and mobility-enhancing products and systems so that their market availability may be accelerated, providing more near-term benefits of crash reductions and transport efficiency. Among other things, this involves research into the areas of crash avoidance and vehicle control to enable the development of these products.

Working jointly with industry and other stakeholders, the U.S. DOT will develop performance guidelines, specifications, architectures, and standards and will test and evaluate the most promising configurations to facilitate their deployment. A major focus of the IVI is to research and evaluate the benefits resulting from these systems, including the integration of driver information systems. These activities will be accomplished through the combined efforts of the U.S. DOT's modal administrations; the motor vehicle, trucking, and bus industries; State and local governments; and other stakeholders, working together under cooperative programs and partnerships to plan for and facilitate the incremental deployment of both vehicle-based and cooperative vehicle-infrastructure-based driver assistance systems.

The IVI will emphasize the significant and continuing role of the driver in achieving improved highway safety. It will cover applications for passenger cars, light trucks, vans, sport and utility vehicles, commercial trucks, transit and intercity buses, and specialized vehicles such as emergency and enforcement vehicles, highway maintenance vehicles, and snow plows, on all types of roads.

4—Background

Planning for the Intelligent Vehicle program must be conducted with the full recognition of the technical and societal issues which will impact the program. The motivation for Government and industrial participation will shape the final program structure.

4.1—The Industrial Context

The primary industrial context that is at issue across the spectrum of near-term Intelligent Vehicle functionalities concerns the automotive industry. Although other industrial segments will contribute to the provision of products, the role of such companies in near-term Intelligent Vehicle product development is not so crucial as is that of automakers and their suppliers. The following observations serve to sketch the industrial context:

- **IVI Systems must be commercially viable.**
- **Products should be implementable in the near term.**
- **Uniformity and standardization of interfaces and protocols will help.**
- **Current Original Equipment Manufacturers initiatives should be embraced.**
- **Required infrastructure components must be available before the private sector will provide vehicle components for cooperative systems.**
- **Other ITS initiatives such as Geographical Information Systems applications may enhance IVI functions.**
- **Driver acceptance must be demonstrated.**

4.2— The Federal Interest in Ensuring Public Benefit from Such Systems

Federal involvements are traced to the missions of respective DOT agencies for improving safety, traffic efficiencies, fuel economy, air quality, etc. The underlying proposition is that a public Intelligent Vehicle program will accelerate the timetable upon which publicly beneficial innovations will become commonly used and will reduce the possibility of degraded safety from nonintegrated after-market applications. Recognizing the need for balance between public benefit and marketability, IVI participants must ensure that reasonably achievable public benefits are identified.

Issues of cooperative infrastructure

Although autonomous systems (all on-board vehicles) are easy to deploy, there may be applications and services for which cooperative infrastructure systems provide greater benefits. To assure that this issue is adequately addressed, both autonomous and cooperative configurations will be considered, and selected systems will be evaluated for performance, user acceptance, and safety benefits.

Standards

The program is constructed in such a way that it will provide research support for a variety of voluntary standards activities. Research that supports development of standards for a specific element of a system will be done with the realization that ultimately it is the entire system that provides the functionality or service. For example, standards for the driver vehicle interface will depend on the sensing capability, human factors, and warning algorithms of a system. As work progresses to support the development of the various standards, it is important to keep in mind that standards should meet several criteria; including being objective (i.e., containing repeatable and objective test procedures); being practicable (i.e., it must be feasible to build systems that meet the requirements of the standard); and meeting a public need (such as improvement of safety) in a quantitative way.

All IVI standards or guidelines should complement existing standards. For example, IVI guidelines or standards may be needed to promote uniformity of information between roadside and in-vehicle systems; otherwise, conflicting meanings could lead to driver confusion, indecision, and safety compromises.

Matters associated with international competitiveness

Because the Federal administrative role in any governmental program is ultimately accountable to Congress, the industrial and social impacts of the activity may well be perceived in light of political themes. Accordingly, for example, it is likely that the impact of Intelligent Vehicle participation on the international competitiveness of firms will be an issue of some concern. In this regard, it seems likely that some foreign-based companies will be able to offer either more advanced technology, more experience in near-term driver assistance applications, and/or more enthusiasm for collaboration than some domestic counterparts. Such a development should be anticipated in the setting of policy on Intelligent Vehicle participation, thus balancing the desire to accelerate the launch of publicly beneficial products against national concerns that trace ultimately to domestic employment and the health of a major domestic industry.

4.3— The Challenge Posed by Modern Driver Assistance Functions

As the Intelligent Vehicle program addresses a broad array of driver assistance systems, we should be generally aware that the tack upon which we are sailing is into truly uncharted waters. The basic question is, How hard will it be to get each of the various system concepts into a truly market-worthy stage of development? After all, we're designing a technology to fit the perception, cognition, and behavior of virtually the entire citizenry, in an everyday safety-critical function. Despite advancements over the past 100 years, no aspect of automotive technology has ever tried to accomplish what the human driver does with his/her eyes in terms of assessing the immediate need for speed and path control. Rather, the remarkable capabilities of human visual performance and the higher cognitive faculties by which risk-taking is judged and adaptation occurs surely explain a great deal about the success of the motor vehicle, under human control. Thus it is a bold proposition that automotive technology would complement the functional space previously occupied only by human perceptions and cognitive capability. The endeavor becomes more complex when drivers are provided with additional in-vehicle information which might, unless carefully designed, compromise driver safety and efficiency.

5—Values

Equity: The improvements achieved through this program will be made available to all highway users in a fair and nondiscriminatory manner.

Decision Making: Balanced and appropriate decisions will be made to reflect the issues and concerns of those impacted and to consider system performance, user acceptance, and cost and safety benefits. Decision making will be shared by the modal administrations of the U.S. DOT in coordination with the ITS Joint Program Office. The guidance provided by stakeholders will be considered in this process.

Collaboration: Achieving the vision requires the joint participation of a variety of disciplines and organizations. This value is at the heart of the IVI program, whose mission will be achieved by the U.S. DOT in collaboration with the industry and its stakeholders.

Leadership: The U.S. DOT intends to lead the initiation of the IVI program.

6—Goals and Strategic Objectives

6.1—Goals

The goals of the IVI program mirror those of the U.S. DOT, as follows:

Primary Goal	*SAFETY* Reduce highway crashes and resulting injuries and fatalities.
Secondary Goals	*MOBILITY* Improve public access to activities, goods, and services. *EFFICIENCY* Improve the utilization of the existing highway system and reduce travel time. *PRODUCTIVITY* Improve the economic efficiency of the Nation's highway transportation system and reduce operating costs. *ENVIRONMENTAL QUALITY* Reduce motor vehicle fuel consumption and emissions.

6.2—Strategic Objectives

The IVI program goals can be achieved by doing the following:

- **Increasing the percentage of new vehicles sold or equipped with human-centered Intelligent Vehicle systems.**
- **Increasing the percentage of the Nation's roads equipped with the necessary Intelligent Vehicle infrastructure.**

6.3—Program Outcome Goals

As a direct result of the activities of the U.S. DOT, our industry, and its stakeholder partners, the following outcomes will be achieved:

a) Accelerate the commercial availability of integrated driving information, driver assistance, and control systems that will improve significantly the safety of light vehicles (including passenger cars), transit buses, commercial truck and intercity buses, and specialty vehicles, such as emergency and road utility vehicles.

b) Develop and validate performance specifications and design guidelines for IVI systems that will be deployed in motor vehicles in the next 10 years.

c) Evaluate the impact of IVI systems on driving safety in recognition of the complexity of the driving task and issues such as risk compensation and workload.

d) Reach agreement on the basic functional requirements for driver assistance features, and target those functionalities for which industry investment has developed or is interested in developing the basis for working prototypes.

e) Recognizing the need for balance between public-benefit and private incentive, ensure that reasonably achievable safety benefit goals are identified.

f) Identify and apply refined and more detailed estimates of benefits in order to assess which deployment investments can be justified and to stimulate new safety products.

g) Identify and conduct the research and development required to achieve increased levels of IVI system capability.

7—Strategy/Initiative

In order to fulfill the program requirements, the IVI must identify and conduct the necessary research to ensure that the driver warning, driver assistance, driver intervention, and travel information systems work effectively and reliably in both independent and integrated modes; that they operate in a consistent and efficient manner; that they are easily understood by drivers; and that drivers accept and use the systems.

Ongoing and recently completed work on crash avoidance, in-vehicle information systems, automated highway systems, and motor carrier issues will provide a strong foundation for IVI research. Research will continue throughout the IVI program. This research will address areas such as human factors, sensor performance, conditions where warnings are needed and conditions where warnings would be a nuisance, modeling, evaluation methods, and other in-vehicle and highway-based technologies. The IVI will include assessment of driver acceptance. A mix of analytic, test track, and on-road research and testing is anticipated. Following testing in an experimental environment, fleets of equipped vehicles will be evaluated in on-road operational settings at various stages of the program.

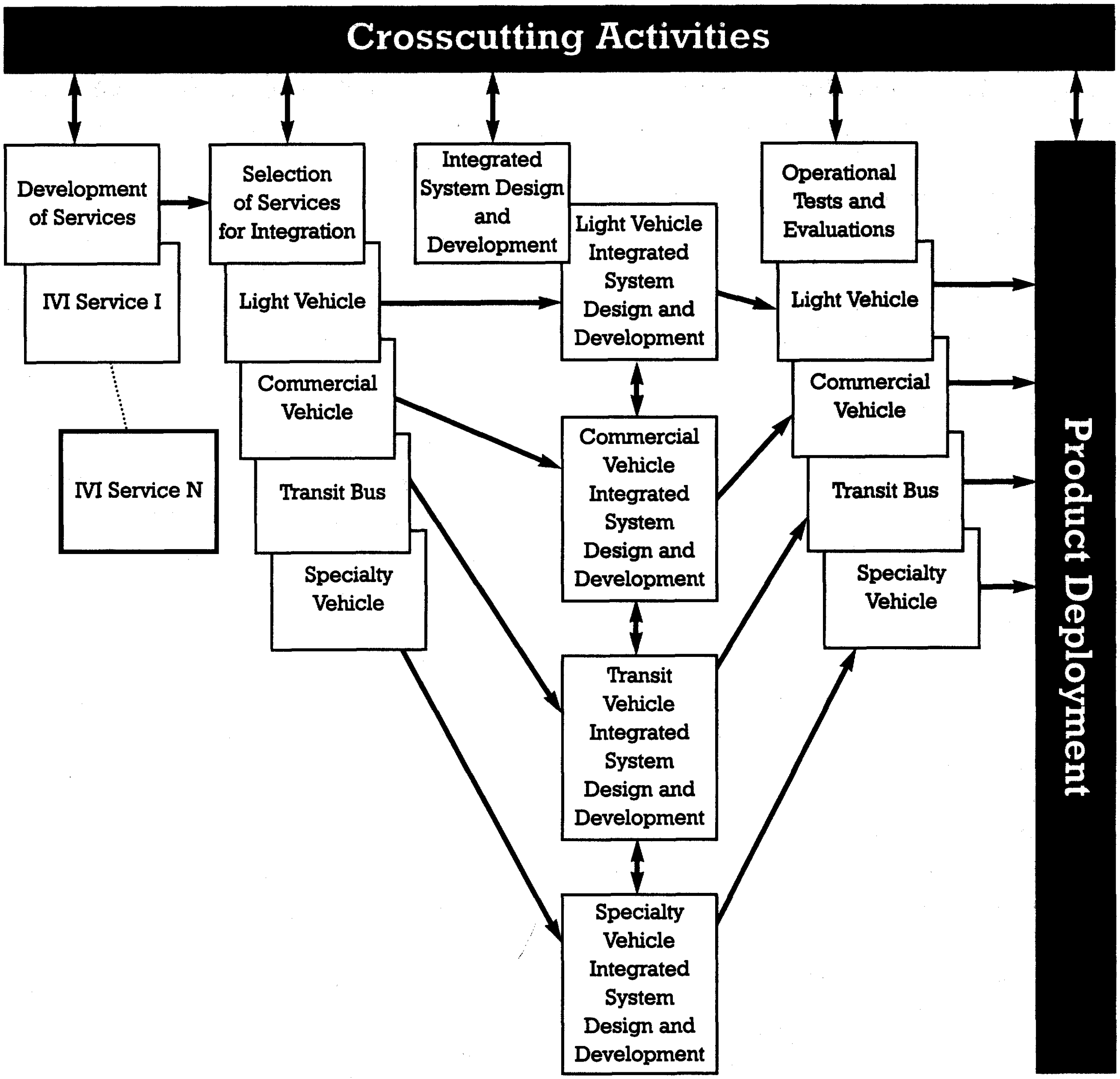
The U.S. DOT will aggressively pursue partnerships and other cooperative arrangements with the motor vehicle, trucking, and bus industries and their suppliers, States and other Government organizations, academic institutions, and other interested parties to fulfill the program requirements.

The U.S. DOT developed a road map of how the IVI program would proceed. A diagram of the road map is shown on the following page.

This road map represents an attempt to illustrate the broad IVI program elements and the sequence in which these program elements would be accomplished. The duration of the IVI program runs from left to right; it is not drawn to scale. The major boxes in the road map include the following:

1. **Crosscutting activities represent groups of actions that influence and guide all the major program elements. They include such topics as: architecture and standards development; research, development, and testing in human factors, communications, and technology; acquisition, expansion, and validation of evaluation tools such as simulation models; development and execution of an outreach plan to ensure joint participation of industry and other stakeholders; development and implementation of field operation evaluation plans; program planning and administration covering IVI program definition and oversight; and any other crosscutting functions and responsibilities not covered elsewhere. The technical issues for many individual services are expected to be independent of the vehicle platforms, and when this occurs, such issues would be studied together.**

Preliminary High-Level Road Map for IVI



2. Development of services would cover the research, development, testing, and evaluation of individual crash avoidance and efficiency-enhancing systems, such as those listed under the caption "Candidate Services" in this document.

3. Selection of services for integration represents the activities necessary to select specific IVI services (and systems to fulfill those services) and the mix of services that should be included in integrated packages of multiple IVI services. Selection involves extensive work on estimating the benefits and costs, as well as anticipated user acceptance of integrated systems that provide a combination of services.

4. The integrated system design and development step covers the research, development, and prototype testing necessary to fulfill the requirements for fully describing IVI capabilities, as well as system and subsystem specifications for the construction of the vehicles and the infrastructure modifications necessary for field operational tests of integrated systems.

5. The operational tests and evaluations activity, as expected, implements the plans for field tests in real-world settings on actual highways, executes a complete evaluation of the integrated IVI services subjected to the operational tests, develops deployment plans, establishes performance thresholds based on objective test performance, and develops recommendations.

6. Product deployment refers to the actions by motor vehicle manufacturers and their suppliers to make and offer IVI systems to highway users in production motor vehicles. It is anticipated that the IVI systems, after operational tests demonstrate the benefits of their integrated services, would be adopted by manufacturers as part of their standard product lines. Product development also includes actions by State, regional, and local governments to install infrastructure-based IVI system components on their highway systems. This activity is indicated as the final step and the ultimate objective of the IVI program.

Candidate Services

The U.S. DOT has concluded that the services described on the following pages are prime candidates for improvement through application of advanced in-vehicle or cooperative technology. It is expected that during the course of the IVI program, the mix of individual IVI services selected for integration may vary among passenger vehicles, trucks, and buses. Please note that these services include some existing or slightly modified ITS user services. The following categories of advanced technologies are identified as candidate IVI services because they: (1) improve safety; (2) may impact safety; (3) provide platform-specific functions; or (4) provide supporting capabilities for other future services.

Safety Services

1. **Rear-End Collision Avoidance:** This feature would sense the presence and speed of vehicles and objects in front of the equipped vehicle and would provide warnings and limited control of the vehicle speed (coasting, downshifting, or braking) to minimize risk of collisions with vehicles and objects in the vehicle's lane of travel. It is expected that the first implementation of this service would be through autonomous in-vehicle systems. These systems would monitor the motion and location of vehicles and other objects in front of the vehicle and would advise the driver, through an appropriate driver-vehicle interface, of imminent rear-end crashes. These systems may share some elements of, and are expected to complement the performance of, adaptive cruise control systems that are expected to precede collision avoidance systems as a commercial product. Later versions of these systems may include automatic braking in the event of an impending crash. The performance of these systems may be enhanced through future combination with other systems, such as other collision avoidance systems, route guidance-navigation systems with enhanced map databases, and cooperative communication with the highway infrastructure to set adaptive cruise control systems at safe speeds.

2. **Road Departure Collision Avoidance:** This feature would provide warning and control assistance to the driver through lane- or road-edge tracking and by determining the safe speed for road geometry in front of the vehicle. It is expected that the first implementation of this service would be through autonomous in-vehicle systems. These systems would monitor the lane position, motion relative to the road edge, and vehicle speed relative to road geometry and road conditions and would advise the driver, through an appropriate driver-vehicle interface, of imminent unintentional road departure. Later versions of these systems may include cooperative communication with the highway infrastructure to automatically provide safe speeds for upcoming road geometry and conditions. The performance of these systems may be enhanced through future combination with other systems, such as other collision avoidance systems, drowsy-driver advisory systems, and route guidance-navigation systems with enhanced map databases.

3. **Lane Change and Merge Collision Avoidance:** It is expected that the first implementation of this service would be through in-vehicle systems which may be augmented with vehicle-to-vehicle communications. These systems would monitor the lane position and the relative speed and position of vehicles, including motorcycles, beside and to the rear of the vehicle. They also would advise the driver during the decision phase of a lane-change maneuver, through an appropriate driver-vehicle interface, of the potential for a collision. Later versions of these systems may provide additional advice of an imminent crash to the driver during the action-phase of the lane change or entry-exit maneuver. The performance of these systems may be enhanced through future combination with other systems, such as other collision avoidance systems and roadside communication and sensing systems.

4. **Intersection Collision Avoidance:** It is expected that the first implementation of this service would be through in-vehicle systems that are augmented by information from enhanced map databases or from cooperative communication with the highway infrastructure. These systems would monitor position relative to intersection geometry, monitor relative speed and position of other vehicles in the vicinity of the intersection, and advise the driver, through an appropriate driver-vehicle interface, of appropriate action to avoid a violation of right-of-way or to avoid an impending collision. Complexities of providing this service include the need to sense the position and motion of vehicles and the need to determine the intent of these vehicles to turn, slow down, stop, or violate right-of-way. A fully autonomous in-vehicle system would probably not be capable of providing this service.

5. **Railroad Crossing Collision Avoidance:** This feature would provide in-vehicle warnings to drivers when they approach a railroad crossing that is unsafe to enter due to approaching or present rail traffic. Initial implementation of this feature is anticipated for buses and trucks carrying hazardous cargo. This service, which would share many on-board vehicle components with intersection collision avoidance systems, is dependent on communications and the deployment of infrastructure components.

6. **Vision Enhancement:** It is expected that the first implementation of this service would be through autonomous in-vehicle systems. These systems would use infrared radiation from pedestrians and roadside features to provide the driver with an enhanced view of the road ahead. Later versions of these systems may include additional information from improvements in the highway infrastructure, such as infrared reflective lane-edge markings.

7. **Location-Specific Alert and Warning:** This feature would provide intelligent in-vehicle warning information by integrating vehicle speed and pertinent vehicle dynamics information with knowledge of road geometry (from a map database or beacon input). Later versions would include information about environmental and road surface conditions to provide the driver with warnings, such as excessive speed for curves or alerts on upcoming traffic signs and signalized intersections. This feature may include the ability, at unusually complex and hazardous highway locations, to provide in-vehicle warnings that replicate one or more types of roadside signs. These capabilities would be integrated with other in-vehicle navigation and route guidance features with collision avoidance warning.

8. **Automatic Collision Notification:** It is expected that the first implementation of this service would be through in-vehicle systems that are augmented by communication links to Public Safety Answering Points (PSAPs). These systems would monitor the position of the vehicle and the severity of the crash. This information would be transmitted automatically to the appropriate PSAP for the location of the crash. These systems may also be combined with manually activated systems for requesting roadside assistance.

9. **Smart Restraints and Occupant Protection Systems:** This feature would provide advance warning of impending (forward or side) crashes and would pre-deploy the appropriate protection systems in a vehicle prior to the impact to obtain maximum protection for the vehicle occupants. If reliable under all potential impact situations, this might permit slower deployment speeds for the air bags, allow for pre-tensioned or load-limited belt systems or smart head protection systems, and ultimately provide more protection for the vehicle occupants.

Safety-Impacting Services

10. **Navigation/Routing:** This feature would provide location and route guidance input to the driver and would support the various collision avoidance capabilities with road geometry and location data. It would also provide the necessary capability to filter traffic information to select those messages that are applicable to the vehicle location and route of travel. It would also offer the capability to recommend optimal routing based on driver preferences. More advanced versions of this service may integrate real-time traffic conditions into the calculations of optimal routes. For paratransit applications this would assist passenger demand and record keeping.

11. **Real Time Traffic and Traveler Information:** These IVI systems would have capabilities to access in-vehicle databases and receive travel-related information from the infrastructure (roadside or wide-area transmissions). Information categories would include items such as vehicle location and route guidance instructions, motorist and traveler services information, safety and advisory information, and other real-time updates on conditions such as congestion, work zones, and environmental and road surface conditions. This feature would provide an integrated approach to the presentation of information to the driver for safety warnings and other advisories related to the driving task. More advanced system capabilities would include the ability to react to dynamic information on environmental and road conditions, thereby augmenting information contained in the static map databases.

12. **Driver Comfort and Convenience:** This service is included in the IVI program to ensure that the increasing number of comfort and convenience features in vehicles, such as cellular telephones and fax machines, do not distract the driver or increase the complexity of the driving task. This service would integrate these features into the driver vehicle interface to permit prioritization of information sources and reduce distractions. Real-time dispatching for fleet operations is included in this category.

Platform Specific Services—Commercial Vehicle

13. **Vehicle Stability Warning and Assistance:** An early version of this service would assist drivers in maintaining safe speeds on curves by measuring the rollover stability properties of a typical heavy vehicle as it is operated on the roadway, and by providing the driver with a graphical depiction of the vehicle's loading condition relative to its rollover propensity. More advanced services would employ an active brake control system coupled with electronic brake system technology and

infrastructure-provided information alerting drivers to selectively apply brakes to stabilize the vehicle and, thus, reduce the incidence of rear-trailer rollover in double-and triple-trailer combination vehicles during crash avoidance or other emergency steering maneuvers.

14. **Driver Condition Warning:** This service would provide a driver monitoring and warning capability to alert the driver to problems such as drowsiness. It is expected that the first implementation of this service would be on commercial and transit vehicles.

15. **Vehicle Diagnostics:** The vehicle diagnostic information service would be an extension of current vehicle monitoring and self-diagnostic capabilities such as oil pressure and coolant temperature gauges. This service would monitor vehicle safety-related functions. Examples of conditions monitored include braking system integrity, tire pressure, sensor and actuator performance, and the communication system. This information is intended to be useful to the driver, as well as to assist and support fleet maintenance and management functions.

16. **Cargo Identification:** This service would focus on heavy-vehicle operation, especially hazardous material transportation. This feature would identify and monitor key safety parameters of the cargo, such as temperature, and pressure. The driver would be warned if any unsafe conditions existed.

17. **Automated Transactions:** This feature would implement capabilities for electronic transactions, such as electronic toll collection, parking fee payment, transit fare payment, and additional commercial vehicle-related functions such as credentials and permit verification, using such technology as transponders and "smart cards."

18. **Safety Event Recorder:** This feature would record selected driver and vehicle parameters to support the reconstruction of conditions leading to a critical safety event. Data from this recorder could provide input to the crash notification subsystem for transmission of collision data to the emergency service provider.

Platform Specific Services—Transit Vehicles

19. **Obstacle/Pedestrian Detection:** This service would warn the driver when pedestrians, vehicles, or other obstacles are in close proximity to the driver's intended path. This could be accomplished with on-board sensors or infrastructure-based sensors communicating to vehicles.

20. **Tight Maneuver/Precision Docking:** This service would position the bus or commercial vehicle very precisely relative to the curb or loading platform. The driver would maneuver the bus into the loading area and then turn it over to automation. Sensors would continually determine the lateral distance to the curb, front and rear, and the longitudinal distance to the end of the vehicle loading area. The driver would be able to override at any time by operating brakes or steering and would be expected to monitor the situation and take emergency action if necessary (for example, if a pedestrian steps in front of the vehicle). When the vehicle is properly docked, it

would stop and revert to manual control. In freight or bus terminals this service could increase facility throughput as well as safety.

21. Transit Passenger Monitoring: This service would assist the driver in detecting any passenger activities that may affect the safety or security of the vehicle's operation.

22. Transit Passenger Information: This service would provide transit passengers with real-time transit network information during travel. The emphasis within the IVI program would be to reduce the nondriving task workload of the driver by providing alternative means for passengers to access location and transit service information.

Platform Specific Services—Special Vehicle

23. Fully Automated Control at Certain Facilities: This service would enhance efficiency and productivity by providing automated movement of vehicles in dedicated facilities. Initial applications may include automated bus movement in maintenance areas and automated container movement within a terminal area. The transit bus application could be a preliminary use of automation in a low-speed, controlled environment. The automated container movement application would consist of using vehicle automation technologies to move containers within rail-, truck-, or shipyards or other centralized facilities.

Supporting Services

24. Low-Friction Warning and Control Assist: This service would initially warn the driver of reduced traction, but, in advanced configuration, would also provide control assist capabilities to assist the driver in regaining control of the vehicle. Sensors on-board the vehicle would detect when the tire-to-road surface coefficient of friction is reduced due to water, ice, or road surface condition.

25. Longitudinal Control: Longitudinal control would range from normal cruise control to applications that permit full automatic braking. Intelligent cruise control senses the presence and relative velocity of moving vehicles ahead of the equipped vehicle and adjusts the speed of travel to maintain a safe separation between vehicles. Vehicle speed is adjusted either by allowing the vehicle to coast or by transmission downshifting. More advanced longitudinal control systems would be capable of detecting a vehicle ahead in the same lane which may be traveling at any speed or may be fully stopped. A full range of braking capability and operating speeds would be available to the equipped vehicle, including stop-and-go traffic operations. This service can be provided by autonomous in-vehicle systems or with assistance from vehicle-to-vehicle and vehicle-infrastructure cooperation.

26. Lateral Control: This service would sense the center of the lane and continually actuate the steering to keep the vehicle in the center of its lane. For the service to dependably detect the lane boundaries, some infrastructure cooperation may be required, such as accurately painted lane-marker stripes, embedded magnetic nails, or radar-reflective stripes. The driver would be able to assume control at any time.

8—Program Funding and Delivery

8.1—Program Funding

The administration's NEXTEA proposal requests a minimum $25 million annually to fund the Intelligent Vehicle program from contract authority. The Department expects that total funding will be at or near the FY 1998 budget request of $50 million. There will be a mix of fully funded, Government-sponsored research, as well as collaboration with industry and other stakeholders under cooperative agreements. The cooperative agreements will require a minimum cost share ranging from 20 to 50 percent.

8.2—Program Delivery

The IVI program will operate under the guidance of a public/private-sector working group. Within the U.S. DOT, the IVI program will be jointly managed by FHWA, FTA, and NHTSA, with the ITS Joint Program Office responsible for coordination and budget oversight. Guidance and direction will be sought from all stakeholders that are not represented in the Working Group.